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SCIENCE

FRIDAY, MAY 30, 1913

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THE JOSEPH LEIDY LECTURE

INTRODUCTION BY THE PROVOST OF THE UNIVERSITY OF PENNSYLVANIA

JOSEPH LEIDY was a son of the University of Pennsylvania. As a token of reverence and affection his devoted nephew and namesake, Joseph Leidy, Jr., has generously endowed the Joseph Leidy Memorial Lectureship for the extension of scientific knowledge through the medium of lectures by eminent specialists.

To-night, we meet to inaugurate this foundation. Of Dr. Leidy, the great student and teacher, whom many of us knew and deeply honored, I would say:

"The wisest man could ask no more of fate
Than to be simple, modest, manly, true,
Safe from the many, honored by the few;
Nothing to count in world, or church, or state,
But inwardly in secret to be great;
To feel mysterious nature ever new,
To touch, if not to grasp, her endless clue,
And learn by each discovery how to wait,
To widen knowledge and escape the praise;
Wisely to teach because more wise to learn;
To toil for science, not to draw men's gaze,
But for her love of self denial stern;
That such a man could spring from our decays
Fans the soul's nobler faith until it burn."

EDGAR F. SMITH

A TRIBUTE TO JOSEPH LEIDY¹

JOSEPH LEIDY was a Philadelphian by his birth, by his career and by his death, and no citizen of this metropolis has more deserved public honor than he.

Leidy was born September 9, 1823, and died April 30, 1891. His first scientific paper was published in 1845, and his last

¹ Opening address for the Joseph Leidy Foundation delivered at the University of Pennsylvania, April 17, 1913.

in 1891. For forty-six years he was an active contributor to *SCIENCE*. The list of his publications, prepared by his nephew, gives 597 titles. A large part of these are brief communications to the Academy of Natural Sciences in Philadelphia, but the list includes also a series of articles and memoirs, some of them of considerable extent, and all valuable. Leidy's investigations are among the classics of American science.

He represents a type of scientific man which seems in our days of specialization and of elaborate laboratories almost extinct. He was a naturalist, and was one of the group of four distinguished true naturalists who have done most for the introduction of natural science into American life. These four men—Louis Agassiz, Spencer F. Baird, James D. Dana and Joseph Leidy—were contemporaries. They all took a similar view of nature. She was a whole made up of many parts played together, and they were interested in the whole drama. Their delight was to go forth and see the world and watch the co-ordinated working of its parts. The correlation between living beings and physical forces appealed to them. They were quite untouched by what we may call the "laboratory spirit," which has arisen since their time—that spirit which isolates an object or phenomenon indoors in order to apply to it all the finest resources of modern scientific equipment. These men, on the contrary, went out of doors to see and study, and the spoils which they brought home were investigated without any elaborate appliances. Young zoologists, botanists and geologists of to-day find these methods too toilsome. In one passage Leidy points out that the studies of the living fauna of our streams and ponds may be carried on by a simple microscope, such as even our elementary students of

to-day would scarce deign to use, yet how varied, interesting, and even wonderful the observations which Leidy has recorded! One has only to look through his collected researches in helminthology and parasitology, published by the Smithsonian Institution in 1904, to gain a clear impression of the enormous extent and variety of these observations. He searched all sorts of animals, insects, vertebrates, molluscs and found a great number of parasitic plants and animals, concerning which he reports many original observations. Many of the species discovered were new to science and were named by him. Nearly the whole of the material he studied was collected by himself, for the most part on little trips he made in the neighborhood of Philadelphia. I quote his own quaint reference to these excursions:

"Going fishing?" How often the question has been asked by acquaintances, as they have met me, with rod and basket, on an excursion after materials for microscopic study. "Yes!" has been the invariable answer, for it saved much detention and explanation; and now, behold! I offer them the results of that fishing. No fish for the stomach, but, as the old French microscopist Joblet observed, "some of the most remarkable fishes that have ever been seen"; and food-fishes for the intellect.

Although professor of anatomy at this university for a long time (1858–1891), his heart was always in his natural-history studies. He did, to be sure, write a textbook of anatomy, undertaken, it is said, only after much urging by the publisher, but it was only an unessential episode in his life. Yet he knew how to use his anatomical opportunities, and he has given us valuable notes on the inter-maxillary bone in man, on the structure of the liver, on reversal of the viscera, etc. But his real life was the exploration of nature. He acquired intimacy not only with animals, the chief objects of his study, but

also with plants, stones and minerals. He collected extensively, his herbarium which he presented to the university contained over 1,500 species, all determined by himself, and his mineralogical collection has been described as "very fine and valuable" and was purchased by the National Museum in Washington. But his chief collections were of animals, especially of such as offered opportunity for microscopical study. The quotation read a few moments ago refers to his gathering of fishes—the particular "fishes" in this case were the Rhizopods. His monograph of this group of unicellular animalcules appeared in 1879 as one of the quarto volumes of the Hayden Survey, and contains a vast amount of original observation and is illustrated by thirty plates, after his own drawings of the living animals. Another extensive work was entitled "Flora and Fauna within Living Animals," one of the most important contributions to parasitology we possess. It was published in 1851 by the Smithsonian Institution in Washington, and is illustrated by ten exquisite copper plates, so skillfully engraved by Oudet that they worthily reproduce the author's beautiful drawings.

The range of work we have already indicated is sufficient to more than occupy an able man, and the results published by Leidy in the field of zoology proper would alone suffice to assure his place among the most distinguished investigators of America. His actual reputation, however, rests at least in equal measure upon his achievements in vertebrate paleontology, which received a richly deserved recognition when the Geological Society of London awarded him in 1884 the Sir Charles Lyell medal. His monographs on American fossil vertebrates laid the foundations of our present knowledge, and first marked out the way by following which Cope and

Marsh and their younger successors have attained distinction. Mention may be made especially of the first memoir of the series, "The Ancient Fauna of Nebraska, a Description of Extinct Mammalia and Chelonia from the Mauvaises Terres of Nebraska," published in 1854 in the sixth volume of the Smithsonian Contributions to Knowledge. The wonderful Eocene deposits of the Bad Lands had not been long known, and the collections available had been hardly more than skimmings from the surface. Leidy by the friendly cooperation of the few collectors of the time was able to inspect practically all the remains which had been gathered. The plates are superb lithographs drawn by the talented Sonrel. In 1855 followed the memoir on the Sloths, in 1865 on the Cretaceous reptiles, and other memoirs in later years (1869, 1873 and 1877).

A special extraneous interest attaches to Leidy's paper on the extinct sloths, for it includes a careful description of *Megalonyx Jeffersoni*, the first remains of which were discovered in Virginia and were described by no less a person than Thomas Jefferson at a meeting of the American Philosophical Society on March 10, 1797. The bones were soon after identified by Dr. Caspar Wistar as not those of a carnivore, as thought by Jefferson, but of a sloth. Casts of these bones were sent to Cuvier, who studied them. I am told that the originals, collected by Jefferson, are now in the collection of the Academy of Natural Sciences in this city.

It happened that the study of vertebrate paleontology in the seventies and eighties of the last century was pursued with great zeal, but also unfortunately with certain rivalries, which aroused acrimonious feelings, too often publicly expressed. Leidy shrank from controversy and it is said that rather than risk being entangled in dis-

putes, so little to his taste, he withdrew from paleontological work altogether.

Leidy was a student of facts, a lover of positive knowledge. His attitude is indicated by the following words from the preface to his article on the extinct mammalia of Dakota (1869):

The present work is a record of facts. . . . No attempt has been made at generalizations or theories which might attract the momentary attention or admiration of the scientific community.

Note the implied scorn of hasty speculation, and remember that in 1869 most biologists had been carried off their feet by the whirlwind of speculation which arose in the wake of the Darwinian theory. Leidy remained undisturbed, a firm devotee of objective research.

Leidy's connection with the Philadelphia Academy of Natural Sciences was long and intimate. His earliest publication known to me was a communication to the academy in 1845. Two years later he became chairman of the board of curators; the collections of the academy long profited by his devotion and wide knowledge of natural history. From 1881 until his death he was president.

For nearly fifty years Leidy was a constant attendant at the meetings of the Philadelphia Academy and very often had matters of interest to communicate, many of which are briefly recorded in the *Proceedings*. Sixty years ago the meetings of local scientific societies had an importance and a charm, which have been much diminished by the developments of the last twenty-five years. A generation ago there were fewer specialists, and narrow interests did not dominate the majority of scientific workers as much as to-day. When naturalists met they spoke a common language, and were mutually interested in one another's discoveries—sixty years ago. There were no national special societies,

and no express trains to bring the members together for three days, and to scatter them asunder for three hundred and sixty-two days—sixty years ago. The knowledge of the individual was less intensive, but his outlook was broader—sixty years ago. To this old order—now passed forever—Leidy belonged. The range of his interests and of his contributions, as revealed by a careful study of the *Proceedings of the Academy of Natural Sciences*, is astonishing, if viewed from the standpoint of cotemporary specialization. There are statements in his usually brief notes in the *Proceedings* concerning regeneration in Planarians, the formation of the cell wall after the division of the cells, on the occurrence of internal parasitic plants in various animals, on bacteria in the intestine of toads, the sense of smell in snails, on a new fossil, on the structure of cartilage, parasitic worms, sponges, Infusoria, Rotifera, Annelids, extinct reptiles, fishes, parasitic Hymenoptera—all incidental and in part accidental observations, but reported with unflinching accuracy.

It should be recorded that time has greatly emphasized the importance of some of Leidy's original discoveries, as of the existence of a bacterial flora in the intestine (1849). Particularly noteworthy are his experiments with cancer, made in 1851.² He transplanted small fragments of a human cancer under the skin of a frog and found that they maintained themselves for a long period. At the close of the communication, the author says:

The experiment not only proved the independent vitality of the tissues, which was generally admitted, but also rendered it extremely probable that cancer was inoculable, for, as in the experiments, the cancerous fragments continued to live when introduced into cold-blooded animals, they

² *Proceedings Acad. Nat. Sci., Philadelphia*, V., p. 212.

would probably not only continue to live when introduced into warm-blooded animals, but would grow or increase in size.

The transplantation of tumors has become an important method of pathological research. We should not forget that Leidy originated the method.

Leidy's supreme gift was the ability to see, coupled with an inexhaustible delight in seeing. He saw so well not only with his eye, but with his intelligence and interpreting mind, that his published observations maintain a level of accuracy to which few naturalists have risen. His characteristic accuracy shows equally in his brief notes and in his extended monographs—it seems never to have failed. Dr. Thomas G. Lee says of Leidy's publications that they "probably contain fewer errors of fact and interpretation than those of any other writer on so many and such varied subjects." The joy of seeing is an inborn gift. It manifested itself very early in Leidy and was accompanied by a talent for drawing. This talent was so marked in the boy that his father withdrew him from school when he was sixteen, with the idea of educating him as an artist. But at this age he was already a naturalist, a student of nature by spontaneous instinct. He dissected cats, chickens and other animals and showed such intense interest in comparative anatomy that it was decided that the lad should study medicine. He attended lectures on medicine at the University of Pennsylvania and obtained the degree of doctor of medicine in 1844, and for two years actually practised. In 1846 he was demonstrator of anatomy in Franklin Medical College, and in 1847 he became a teacher in the university under Dr. Horner. In 1850 he had the great advantage of a trip to Europe with Dr. George B. Wood, to collect material to illustrate Dr. Wood's lectures. It gave the young

naturalist fresh stimulus, for he made the acquaintance of a number of famous anatomists and physiologists. The late Mr. Isaac Hinckley was fond of relating how Dr. Wood found it difficult to persuade Leidy to overcome his modesty so far as to send in his card also to Johannes Müller. Presently Müller came into the room, crying out, "Which is Leidy?" Extreme modesty was a marked characteristic of Joseph Leidy throughout his life, and was accompanied by an amiable unselfishness, which endeared him alike to his friends and his students. In 1858, after the death of Dr. Horner, Leidy was made professor of anatomy in the university and continued to fill the chair until his own death, thirty-three years later.

Leidy's death terminated the career of a man whose noble and unflagging devotion to science secured a rich harvest of discovery. He has left a message to us which I deliver to you in his own words:

The study of natural history in the leisure of my life, since I was fourteen years of age, has been to me a constant source of happiness; and my experience of it is such that independently of its higher merits, I warmly recommend it as a pastime, which I believe no other can excel. At the same time, in observing the modes of life of those around me it has been a matter of unceasing regret that so few, so very few, people give attention to intellectual pursuits of any kind. In the incessant and necessary struggle for bread we repeatedly hear the expression that "man shall not live by bread alone," and yet it remains unappreciated by the mass of even so-called enlightened humanity. In common with all other animals, the engrossing care of man is food for the stomach, while intellectual food too often remains unknown, is disregarded or rejected.

It is an honor to Philadelphia that the statue of Joseph Leidy stands by the great city hall. It is an honor to the University of Pennsylvania that his name is to be from this evening forth associated with the university's highest work. We are gath-

ered here to express our reverence for the man and our admiration for the scholar. It is our part to keep alive the tradition of truth-loving, of scientific devotion and of perfect modesty which is our legacy from Joseph Leidy.

CHARLES S. MINOT

*HEREDITY AND MICROSCOPICAL
RESEARCH*¹

I have been much honored by the invitation to deliver the first lecture of a series established in honor of Joseph Leidy, a man distinguished alike for the diversity and importance of his original contributions to knowledge and for the far-reaching influence that he exerted on other men of science, in his own time and after. No American naturalist could be named whose biological interests ranged over a wider field; and the selection of my topic this evening has been influenced in some measure by the fact that Leidy was an almost solitary pioneer of microscopical investigation in this country, at a time when the cell-theory was in the earliest stages of its development, and when no one could have imagined the brilliant future that lay before it. Did time permit I would gladly dwell for a moment on his early observations on the structure and division of cells, and on the activities of the simplest forms of life. Much of his subsequent work lay in a very different field of inquiry, but his interest in microscopical investigation never deserted him, witness to which was borne by the publication in his later life of a beautiful monograph on the fresh-water rhizopods, which at once took its place as one of the classics of American zoology.

¹A lecture delivered before the University of Pennsylvania, April 17, 1913, on the Joseph Leidy Foundation. With the exception of three general diagrams it has been impracticable to reproduce the figures that were shown by means of lantern slides.

More than half a century has passed since Leidy's earliest studies with the microscope. The main motive power behind the unparalleled advance in biology during this period has been the persistent effort to explain the activities of living things through investigations upon their structure, whether anatomical, physical or chemical. This effort entered upon a new era with the discovery of protoplasm and the promulgation of the cell-theory; for its final objective was now seen to lie in minute structural elements, the cells, of which the tissues are composed. Little by little it became clear that the cell, whatever else it be, is a microscopic chemical engine, where the energy of the foodstuffs is finally set free, and applied to the work of life. The question inevitably arose whether we can discover within the cell any visible apparatus by which this is accomplished. The inquiry has a thousand aspects; I ask your attention to that which relates to the problem of heredity.

It long since became clear that the cell-theory offers us a general explanation of heredity. Heredity is a consequence of the genetic continuity of cells by division, and the germ-cells form the vehicle of transmission from one generation to another. This fundamental discovery divested heredity of the mystery in which it had so long been enveloped, though it must always remain among the most wonderful of phenomena. But this result only cleared the way for further advances. Our scientific curiosity is aroused in the highest degree by more specific problems of heredity. Why do individuals now and then appear that show little resemblance to their immediate progenitors but "revert" to much more remote ancestors? Why do the grandparents often exert definite effects upon their grandchildren of which no suggestion is given by their children? What